

The NEAR-Shoemaker Radio Science Results for Asteroids Mathilde and Eros

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As a result of the NEAR-Shoemaker spacecraft's 10 km/s flyby of asteroid 253 Mathilde (to within 1212 km) on June 27, 1997, the mass, bulk density, and porosity of this C-type asteroid were determined. The surprising bulk density of 1.3 ± 0.2 g/cc together with an estimated porosity of more than 50% suggests a rubble pile structure for this C-type asteroid. After achieving a successful orbit insertion about the asteroid Eros on February 14, 2000, the spacecraft spent a full year in orbit about Eros. The variety of orbital heights and paths about the asteroid, together with a comprehensive radiometric and optical landmark data set, enabled a gravity field (10×10) to be determined. Separate processing of the laser rangefinder data provided an accurate Eros shape model. The near identity of the true gravity field and one determined from the shape model (assuming constant density) suggests that Eros is uniformly dense to the 1% level. The observed slight mass deficiency at the ends of Eros could be due to a less dense regolith on the order of 100 meters thick distributed uniformly over the surface or perhaps a slight concentration of material near the center of Eros. Eros' bulk density (2.67 ± 0.03 g/cc) and an estimated porosity of 20 - 30 % suggests this S-type asteroid is a fractured fragment from a once larger asteroid. The combination of the radiometric and optical landmark data allowed an accurate definition for the asteroid's rotation period (5.27025547 hours) and spin pole direction. Both these determinations are consistent with, but more accurate than, values derived from ground-based measurements. Eros appears to be in rotation about its axis of maximum moment of inertia since no evidence of free precession (< 0.01 degree) is evident in the data set.